

STATE OF MISSOURI
DEPARTMENT OF NATURAL RESOURCES

Bob Holden, Governor • Stephen M. Mahfood, Director

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MEMORANDUM

DATE: October 19, 2004

TO: Lina Klein, Environmental Engineer
New Source Review Unit, Permits Section

THROUGH: Jeffry D. Bennett, P.E., Air Quality Modeling Unit Chief *JDB*
Air Quality Analysis Section, APCP

FROM: Adel Alsharafi, Environmental Engineer *AA*
Air Quality Modeling Unit, AQAS

SUBJECT: Revised Aquila-Cass County Air Dispersion Modeling
(South Harper Peaking Facility)

I. Introduction

On September 13, 2004, the Air Quality Modeling Unit (AQMU) received a revised Ambient Air Quality Impact Analysis (AAQIA) for the Aquila Inc. in Peculiar, Missouri. The following paragraphs describe the scope of the proposed project and the methodology used throughout the modeling study to predict ambient air impacts of CO, NO_x, PM₁₀, and formaldehyde.

On April 7, 2004, Aquila-Cass County submitted a permit application for a Prevention of Significant Deterioration (PSD) permit to construct a new simple-cycle combustion turbine power plant near Harrisonville, Missouri. Due to unforeseen circumstances, Aquila moved the site to near Peculiar, Missouri. The new peaking power plant will consist of three (3) simple-cycle turbines with total nominal 341-Megawatts (MW) of electric generating capacity at 75-100 percent loads and ambient temperatures of 0°-95° F. The combustion turbines will be fired

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with natural gas, exclusively. A fire pump and a gas heater will also be installed. Aquila is requesting an annual operating limit of 2000 hours on each turbine. The fire pump and the gas heater will operate 250 hours/yr and 6000 hours/yr, respectively.

II. Related Documents

The modeling file includes the modeling study submitted by Aquila, a model review log, correspondence, and the model inputs and outputs. All of the information is available in the Air Pollution Control Program modeling file for Aquila.

III. Model Selection

The modeling procedures used in this study follow current air quality modeling guidelines. Version 02035 of the Industrial Source Complex Short Term (ISCST3) dispersion model was used to evaluate the impacts of CO, NO_x, PM₁₀, and formaldehyde emitted from Aquila, Peculiar, Missouri.

The ISCST3 is the U.S. Environmental Protection Agency (EPA) approved model based upon the Gaussian plume equation and can be used to model point, area, volume, and open pit sources. The model allows for the input of multiple sources, terrain elevations, structure effects, various grid receptors, wet and dry depletion calculations, urban or rural terrain, and averaging periods ranging from one hour to one year.

IV. Source Data

Table 1 shows the proposed stack parameters of the three turbines for three operating loads (75%, 85%, & 100%), the gas heater and the fire pump. Table 2 shows the proposed emission rates for each operating load. NO_x and PM₁₀ annual emission rates are based on 2000 hours/year limit. Moreover, wastewater maybe injected into the stack of Turbine 1. Therefore, it was modeled with higher PM₁₀ emission rates to account for the wastewater PM₁₀ emissions.

Table 1: Proposed Stack Parameters

Source	Operating Load	Height (m)	Temperature* (k)	Exit Velocity* (m/s)	Diameter (m)
Turbine 1	100%	16.76	786 (766)	17.7 (17.2)	7.32
	85%		745 (725)	15.8 (15.4)	
	75%		727 (708)	14.5 (14.2)	
Turbine 2	100%	16.76	786	17.7	7.32
	85%		745	15.8	
	75%		727	14.5	
Turbine 3	100%	16.76	786	17.7	7.32
	85%		745	15.8	
	75%		727	14.5	
Gas Heater		13.11	616	9.66	0.76
Fire Pump		5.18	804	0.10	0.15

* Temperature and exit velocity of Turbine 1 are less when wastewater is injected.

Table 2: Proposed Maximum Emission Rates

Source	Load	CO (1-hour & 8-hour) (g/s)	NO _x (g/s)	PM ₁₀ (g/s)		Formaldehyde (g/s)
Turbine 1	100%	10.420	2.345	24-hour	1.260 (1.921)*	0.130
				Annual	0.288 (0.439)*	2.961E-02
	85%	8.946	2.011	24-hour	1.260 (1.921)*	0.111
				Annual	0.288 (0.439)*	2.531E-02
	75%	7.938	1.784	24-hour	1.260 (1.921)*	9.954E-02
				Annual	0.288 (0.439)*	2.268E-02
Turbine 2	100%	10.420	2.345	24-hour	1.260	0.130
				Annual	0.288	2.961E-02
	85%	8.946	2.011	24-hour	1.260	0.111
				Annual	0.288	2.531E-02
	75%	7.938	1.784	24-hour	1.260	9.954E-02
				Annual	0.288	2.268E-02

Turbine 3	100%	10.420	2.345	24-hour	1.260	0.130
				Annual	0.288	2.961E-02
	85%	8.946	2.011	24-hour	1.260	0.111
				Annual	0.288	2.531E-02
	75%	7.938	1.784	24-hour	1.260	9.954E-02
				Annual	0.288	2.268E-02
Gas Heater		0.101	0.039	24-hour	9.261E-03	9.084E-05
				Annual	6.035E-03	6.222E-05
Fire Pump		2.142E-02	7.407E-03	24-hour	5.040E-03	4.624E-06
				Annual	1.438E-04	1.323E-07

*PM₁₀ emission rates w/o wastewater injection

V. Receptors

For this dispersion modeling review, Aquila implemented a Cartesian grid with variable spacing. First, receptors were placed at 50 meter intervals along the property boundary. Second, a fine grid with receptors spacing of 100 meters extended to 2 kilometers from the property fence line. Third, a coarse grid with receptors spacing of 250 meters extended to 5 kilometers from the property fence line. Finally, another coarse grid with receptors spacing of 1000 meters extended to 10 kilometers from the facility property fence line.

Terrain elevations were included in the modeling. The elevations were acquired from 7.5-minute topographic maps provided by the United States Geological Survey.

VI. Meteorological Data

The most recent five years of meteorological data were used and included the following years: 1998, 1999, 2000, 2001, and 2002. The meteorological data files were developed using surface from Kansa City International Airport (#3947), Missouri, and upper air data from Topeka Municipal Airport (#13996), Kansas. The files were processed using PCRAMMET. The anemometer height was 10 meters.

VII. Building Downwash

Building downwash was calculated using the Building Profile Input Program (BPIP). The information needed to execute BPIP are the heights and locations of structures, which may contribute to building downwash, and the stack locations in relation to these structures. BPIP serves two main functions. The first function of the program is to determine if a stack is being subjected to wake effects from a surrounding structure or structures. Flags are then set to indicate which stacks are affected by structure wake effects. If a stack is influenced by a structure, then the second function of the program is executed. The second function calculates the building heights and widths to be included in the model so that building downwash effects can be considered.

VIII. Good Engineering Practice Stack Height

The Clean Air Act states that a stack should be high enough to ensure that its emissions do not result in excessive ground level pollutant concentrations in the area surrounding the stack due to downwash effects caused by the source itself, nearby structures, or complex terrain. It also states that the stack shall not exceed two and one-half times the height of the obstructing source unless a demonstration can be made that this is necessary. According to 40 CFR 51.1(ii), good engineering practice (GEP) stack height is the greater of 65 meters (measured from the base of stack) or the height of the nearby structure (measured from base of stack) plus 1.5 times the lesser dimension of the nearby structure. If neither of the above approaches is used to determine GEP stack height, a fluid model study can be conducted.

Aquila's stacks are well below 65 meters and do not have to undergo a detailed GEP evaluation.

IX. Results

Tables 3-5 show that the concentrations of CO, NO_x, and PM₁₀ are below the modeling significance levels of each pollutant. Table 6 shows that formaldehyde's five years concentrations are way below its risk assessment levels.

Table 3: Modeled Concentrations with 100% Load

Year	CO		NO _x	PM ₁₀	
	8-Hour	1-Hour	Annual	24-Hour	Annual
1998	18.21390	76.33681	0.39492	2.59480	0.04109
1999	18.79542	53.92140	0.34237	1.80927	0.04114
2000	22.77084	51.01871	0.36214	1.71664	0.04427
2001	21.69964	52.99957	0.38533	1.78661	0.04661
2002	24.83468	51.07308	0.37122	2.10276	0.03895
Modeling Significance Levels (µg/m ³)	500	2000	1.0	5.0	1.0

Table 4: Modeled Concentrations with 85% Load

Year	CO		NO _x	PM ₁₀	
	8-Hour	1-Hour	Annual	24-Hour	Annual
1998	18.20090	76.33681	0.39471	2.59480	0.04109
1999	18.79541	53.91648	0.34212	1.80910	0.04116
2000	22.76571	51.01028	0.36180	1.71671	0.04429
2001	21.69049	52.99212	0.38527	1.78701	0.04669
2002	24.83468	51.06491	0.37141	2.10258	0.03903
Modeling Significance Levels (µg/m ³)	500	2000	1.0	5.0	1.0

Table 5: Modeled Concentrations with 75% Load

Year	CO		NO _x	PM ₁₀	
	8-Hour	1-Hour	Annual	24-Hour	Annual
1998	18.19193	76.33681	0.39457	2.59480	0.04110
1999	18.79541	53.91292	0.34200	1.80897	0.04119
2000	22.76214	51.00417	0.36157	1.71675	0.04430
2001	21.68440	52.98671	0.38534	1.78725	0.04677
2002	24.83468	51.05897	0.37171	2.10244	0.03915
Modeling Significance Levels (µg/m ³)	500	2000	1.0	5.0	1.0

Table 6: Formaldehyde Maximum 24-hour & Annual Concentrations for the Three Different Loads

Year	24-Hour			Annual		
	Concentration (µg/m ³)			Concentration (µg/m ³)		
	100%	85%	75%	100%	85%	75%
1998	0.02162	0.02102	0.02077	0.00041	0.00041	0.00041

Year	24-Hour			Annual		
	Concentration ($\mu\text{g}/\text{m}^3$)			Concentration ($\mu\text{g}/\text{m}^3$)		
	100%	85%	75%	100%	85%	75%
1999	0.01871	0.01842	0.01873	0.00044	0.00044	0.00043
2000	0.01937	0.01767	0.02020	0.00047	0.00047	0.00047
2001	0.01602	0.01767	0.02420	0.00050	0.00050	0.00051
2002	0.01826	0.01763	0.01795	0.00039	0.00039	0.00040
RAL ($\mu\text{g}/\text{m}^3$)	0.8			0.08		

X. Additional Impact Analyses

In addition to performing an ambient air quality impact analysis, all PSD applicants must evaluate the impact the new source or modification will have on growth, soils, vegetation, and visibility impairment. The following paragraphs outline the procedures that were followed in an effort to address these additional impacts.

Plants, Soils & Animals

The maximum ambient concentrations emitted by a facility must be assessed in order to ensure that adverse impacts do not occur on plants, soils, and animals. Concentrations in excess of the screening levels outlined in the document entitled "A Screening Procedure for the Impacts of Air Pollution Sources on Plants, Soils, and Animals" would trigger the requirements of 40 CFR 52.21 (o) and (p). If predicted concentrations do not exceed the screening thresholds no further analysis is required.

The seven-step process outlined in the above document was followed to screen Aquila's impact on plants, soils and animals. Each step of the process is described in the following paragraphs.

Steps 1 & 2

Steps 1 and 2 in the screening process address airborne pollutants and how exposures to plant tissue can adversely impact growth or cause tissue damage. In Step 1, the impact each pollutant may have is estimated using air quality models. Step 2 in the process compares the predicted ambient concentration to screening thresholds that represent the minimum concentration at which tissue injury or adverse growth effects are realized.

Table 7 entitled “Aquila Screening Concentrations for Exposure to Ambient Air Concentrations” summarizes the results obtained from the ISCST3 dispersion model. None of the exposure thresholds was exceeded.

Table 7: Aquila Screening Concentrations for Exposure to Ambient Air Concentrations

Pollutant	Averaging Time	Vegetation Sensitivity			Background	Modeled Maximum	Total
		Sensitive	Intermediate	Resistance			
CO	One Week	1800000	-----	18000000	4806*	76***	4882
NO _x	4-hr	3760	9400	16920	98**	365	463
	8-hr	3760	7520	15040	98**	230	328
	1-month	-----	564	-----	98**	24	122
	Annual	-----	94-188	-----	15	0.39	15.39

*Background concentration taken from 700 Block Broadway monitoring site, Kansas City, Jackson County.

** Background concentration taken from County Home Road monitoring site, Liberty, Clay County.

***Conservative 1-hr average concentration value.

Steps 3 & 4

Steps 3 and 4 in the seven step screening process address the impact air pollution has on plants and animals once the material is deposited and consequently becomes available for uptake by plants. This screen assumes that all of the deposited material is soluble and available for uptake. For each trace element emitted by Aquila, the concentration in the soil was calculated from the maximum annual average concentration predicted by the dispersion model. The results of this analysis are contained on the attached Table 8, entitled “Aquila Deposition of Trace Elements in Soil.”

The next step in the process is to compare the increase in concentration in the soil to the existing endogenous concentration. This information is used

as a supportive indicator for Step 6 and is not used to show compliance. The attached Table 9 “Aquila Increase Over Endogenous Soil Concentration” summarizes the results obtained from this analysis.

Step 5

In Step 5 the amount of the trace element that could potentially be taken up by plants is calculated and compared to the recommended plant to soil concentration ratio. The attached Table 10, entitled “Aquila Potential Concentrations in Plant Tissue” summarizes the results. This analysis will be used to determine if all applicable thresholds are being met.

Step 6

The concentrations predicted in Step 3 and Step 5 are compared to the screening concentrations in Tables 3.4 and 3.7 in the screening document. The first table compares predicted impacts to the screening concentrations for exposure of vegetation to concentrations in the soil and plant tissues. The second table is used to evaluate the impact trace elements have on the dietary systems of animals and when dietary concentrations become toxic. All of the trace elements are below the screening thresholds. The attached Table 11, entitled “Aquila Screen for Potential Adverse Impacts from Trace Elements” summarizes the results of this analysis.

Step 7

The last step in this process considers the effect of solubility on the ability of plants to uptake trace elements. All of the previous steps assumed that 100% of deposited material is available to a plant for uptake, however, this is not likely to occur in reality. This step is strictly a supportive indicator that looks at the possible effect that reduced solubility would have on predicted concentrations. Step 7 was not performed because the screening levels in Step 6 were not exceeded.

The screening procedures set forth by the EPA in the document entitled “A Screening Procedure for the Impacts of Air Pollution Sources on Plants, Soils, and Animals” indicate that no adverse impact on plants, soils and animals is likely due to the operations at the proposed facility. However, recent information received by the EPA Region VII indicates that large NO_x

emitters should take the soils analysis one step further to include the screening thresholds contained in the document entitled “Air Quality Criteria for Oxides of Nitrogen, Summary of Vegetation Impacts.”

Preliminary investigations indicate that short term exposure to elevated NO_x concentrations alone can cause damage to some sensitive plant species and crops. Table 7 above outlines the minimum concentration to which sensitive, intermediate, and tolerate plants can be exposed to prior to receiving 5% injury to their foliage for various averaging times. Based upon this information, elevated NO_x concentrations over a short time frame can cause more damage than low NO_x concentrations over an extended period of time. The attached Table 12, entitled “Aquila Screen for Adverse Impacts from NO_x Emissions” summarizes the results of this analysis. The current version of the ISCST3 dispersion model does not allow the user to calculate concentrations less than one hour. As such, a comparison between the half-hour tolerance levels could not be made. However, all of the calculated NO_x concentrations fall below the criteria outlined in the guidance document for the remaining averaging times.

The guidance goes on to site recent studies that have indicated that synergy between two or more criteria pollutants can cause vegetative damage at lower concentrations than from a higher exposure to a single pollutant. Specifically mentioned in the documentation is the synergy that occurs between NO_x and SO₂ emissions. Comparison to a specific exposure level is not possible in this instance because the guidance document does not outline concentrations and exposure times where synergy may cause the most harmful impacts to plant foliage and crops.

Class II Visibility Impacts

A Class II visibility analysis is required under the draft PSD guidelines and is separate from the Class I analysis required by the Federal Land Manager. The Class II visibility analysis must be conducted within the impact area of the source at locations that could be adversely impacted by a reduction in visibility such as scenic vistas and sensitive areas such as airports, schools, etc. For this visibility analysis two sensitive areas of an airport and a school that are 2.2 km and 4.4 km away from the facility, respectively, were modeled.

Initially, VISCREEN in the screening model is recommended to evaluate visibility impacts. The Level 1 screening analysis provides a conservative estimate of plume visual impacts under worst case meteorological conditions and a plume/observer relationship that places the plume adjacent to the observer. The results of this analysis are attached. The visual impacts predicted by the Level 1 VISCREEN analysis indicates that the plume visual impact screening criteria are exceeded for both areas. As such, a Level 2 analysis was performed.

Unlike the Level 1 analysis, the Level 2 screening analysis requires an evaluation of both the frequency and distribution of wind speed and direction in order to determine if the plume will remain cohesive as it travels towards the observer located within the area of interest. If the plume is dispersed due to convective activity, it is unlikely that any discoloration of the atmosphere will be visible.

For the Aquila Level 2 analysis, Burns & McDonnell Engineering Company used all defaults in Level 1 analysis and chose wind speed and stability class according to VISCREEN guidance. A wind direction was chosen that transported emissions closest to the given areas (Northeast of the facility). Burns & McDonnell's modeling program (BEEST) made the tables of joint frequency distribution that helped to determine the meteorological data that would be used. In the northeast direction, the wind was (based on joint frequency tables) 5 m/s and the stability was in this direction correlated to 4 (D). According to VISCREEN guidance, emission rates for PM_{10} and NO_x were corrected to reflect maximum short-term rates. The attached results of Level 2 analysis show Class I Screening Levels exceedances outside the school and the airport.

It should be noted that a more refined analysis, which incorporates particle size distributions, plume overlap, and different geometries, could lead to improved Class II visibility results. Additionally, the screening levels are based upon Class I area sensitivities because Class II thresholds have not been issued by the EPA at this time.

Growth

Based upon draft guidance from the EPA, the growth analysis should address the growth that comes about as the result of the proposed facility.

This assessment should include an evaluation of air quality impacts related to any construction, commercial, industrial, or other growth that occurs.

Current growth estimates from the region indicate that both direct and indirect impacts on air quality are anticipated to be minimal based upon the analysis supplied by Burns & McDonnell. As such, the inclusion of secondary emissions was not considered in the AAQIA for Aquila.

XI. Recommendations/Conclusions

Provided that Aquila (South Harper Peaking Facility) adheres to the operating loads and their associated stack parameters and is limited to the emission rates for applicable averaging time shown in Tables 1 and 2, the impacts on ambient air will be lower than the modeling significance levels (MSL) for CO, NO_x, and PM₁₀, and lower than the risk assessment levels (RAL) for formaldehyde. Therefore, the Air Quality Modeling Unit recommends approval of this project with permit conditions specifically limiting each emission point to appropriate averaging time/emission limitations contained in Table 2 (consistent with the operating scenario with and without wastewater injection).

AA:bw

Attachments

c: Adel Alsharafi, Air Quality Analysis Section, APCP
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